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ABSTRACT

This publication offers excerpts from the National Courses of Study revised by the Ministry of Education in Japan. The first section discusses curriculum for kindergarten. It states that lessons must be presented at least 39 weeks a year and the standard number of class periods per day should occupy four hours. Content is classified into four domains, arithmetic being involved in the third domain of environment and not specified as a subject. The next section outlines the mathematics curriculum for elementary school. Arithmetic is required in each grade, and the standard number of class periods per year required for arithmetic is listed for each grade level. Class periods are 45 minutes long with instruction being given at least 34-35 weeks. Educational objectives and content are provided for each grade level. The mathematics curriculum is outlined for the lower secondary school (ages 12-14) with educational objectives and content listed. The final section addresses curriculum for the upper secondary school. A brief summary of a specialized course in science mathematics is also presented. (AIM)

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Excerpt from the National Courses of Study

Revised by the Ministry of Education

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CURRICULUM FOR THE KINDERGARTEN

Revised by the Ministry of Education in 1989, and to be put in force beginning in 1990.

Excerpt from the Course of Study for the Kindergarten

1. Lessons must be given over at least 39 weeks a year.
2. Standard number of class periods per day is 4 hours.
3. Objectives and content are classified into four domains as follows:
   Health, Human Relations, Environment, Language.
   (Arithmetic is not specified as a subject.)

Notes :

1) Children can enter the kindergarten between the ages of 3 and 5.
2) Objectives and content concerning arithmetic are involved in the third domain, ie, Environment.

Environment

1. Objectives

(1) To help children become familiar with the environment around them and become interested in various phenomena through contact with nature.

(2) To help children become involved in the environment around them and become attentive it by incorporating it into their lives.

(3) To help children enrich their sense of the properties of things, numbers and quantities, by seeing, thinking and treating the phenomena around them.

2. Content

(8) Children feel interested in numbers, quantities and geometrical figures in their daily lives.

【(1)～(7) & (9), (10) are omitted, since those items have no relation with arithmetic.】

3. Remarks

(2) As for number and quantity, the teacher should evaluate children's experience based on their needs in their daily lives. Their interest, concern and sense of the number and quantity should be fostered naturally.

【(1) is omitted, since the item has no relation with arithmetic.】

CURRICULUM OF MATHEMATICS FOR THE ELEMENTARY SCHOOL

Revised by the Ministry of Education in 1989, and to be put in force beginning in 1992.

Excerpt from the General Provision of the Course of Study for the Elementary School

1. Arithmetic is a required subject in each grade.
2. Standard numbers of class periods per year required for Arithmetic are prescribed as follows:

1st grade (6 years old)	136
2nd grade (7 years old)	175
3rd grade (8 years old)	175
4th grade (9 years old)	175
5th grade (10 years old)	175
6th grade (11 years old)	175

Notes :

1) Each class period is 45 minutes long.
2) Lessons on Arithmetic must be given over at least 34 weeks in the 1st grade, and over at least 35 weeks in other grades.

Arithmetic

I. OBJECTIVES

The aims are to help children develop their abilities to consider their daily-life phenomena insightfully and logically, acquiring the fundamental knowledge and skills regarding numbers, quantities and geometrical figures ,and thereby to foster their attitude to appreciate the mathematical coping with and to willingly make use of it in their lives.

II. OBJECTIVES AND CONTENT IN EACH GRADE

[1 st grade]

1. Objectives

(1) Through activities such as concrete manipulation, to help children understand the concept of number and how to represent numbers, and to help them be able to use addition and subtraction in simple cases.

(2) Through activities such as concrete manipulation, to help children enrich their experiences basic to understand the concepts of quantity and measurement.

(3) Through activities such as concrete manipulation, to help children enrich their experiences basic to understand the concepts of geometrical figures and space.

2. Content

A. Numbers and Calculations

(1) To enable children to correctly represent the number and order of objects by using numbers, and through these activities, understand the concept of numbers.

a. To compare the numbers of objects by manipulation such as one-to-one correspondence.

b. To correctly count or represent the number and order of objects.

c. To know about the size and order of numbers, to make a sequence of them and to represent them on a number line.

d. To consider a number in relation to other numbers by regarding it as a sum or difference of them.

e. To know how to represent 2-digits numbers and the meaning of place value in them.

(2) To enable children to understand addition and subtraction of numbers and use them.

a. To know about the cases in which addition and subtraction are applied, to represent them by mathematical expressions and to interpret them.

b. To be able to surely carry out addition of 1-digit numbers and subtraction as its inverse operation.

c. To know that addition and subtraction may be applied, in simple cases, to 2 digits numbers as well as to 1 digit numbers.

(3) To enable children to count concrete objects by grouping, dividing them into equal

parts and to represent the result in a neatly arranged way.

B. Quantities and Measurements

(1) To enable children to enrich their experiences basic to understand the concepts of quantities and their measurement through activities such as comparing their sizes.

a. To directly compare quantities such as length, area and volume through concrete manipulation.

b. To compare sizes in terms of the number of unit by regarding size of objects around children as a unit.

(2) To enable children to read a clock.

C. Geometrical Figures

(1) To enable children to enrich their experiences basic to understand the concepts of geometrical figures and space through such manipulative activities as observing the shapes of concrete objects and constructing them.

a. To recognize the shapes of objects or to grasp their features.

b. To construct the various shapes and decompose them into more basic shapes.

c. To represent the position of an object by correctly using such words concerning directions and positions as "front and rear", "right and left" and "upward and downward".

【 Terms / Symbols 】

ones place, tens place, +, −, =

3. Remarks concerning Content

(1) As for the content A-(1)-e, it is necessary to assure the understanding of 2-digits numbers through alluding to simple 3-digits numbers.

(2) As for the content C-(1)-a, it is necessary to help children gradually pay attention to the functional aspect of shapes of objects.

[2 nd grade]

1. Objectives

(1) Through activities such as concrete manipulation, to help children deepen their understanding of the concept of number and how to represent numbers. Furthermore, to help them understand addition, subtraction and multiplication and

become able to do in basic calculations as well as to help them become able to adequately apply them.

(2) Through activities such as concrete manipulation, to help children gradually understand the concepts of quantities such as length and volume and their measurement as well as to help them become able to measure them.

(3) To help children become able to gradually understand the concepts of fundamental geometrical figures by paying attention to the elements that compose them.

2. Content

A. Numbers and Calculations

(1) To enable children to understand the concept of number and how to represent numbers, and develop their abilities to use them.

a. To count objects by rearranging them into groups of the same size or by classifying them.

b. To understand how to represent numbers up to 4-digits numbers by the decimal positional numeration system (Hindu-Arabic numeration system) and the size and order of the numbers.

c. To understand relative size of numbers by regarding 10 as a unit or 100 as a unit through concrete manipulation.

d. To consider a number in relation to other numbers by regarding it as a product.

e. To classify simple facts and represent them by using numbers.

(2) To enable children to develop their abilities to use addition and subtraction through getting deeper understanding of them.

a. To understand the mutual relation between addition and subtraction.

b. To understand that addition and subtraction of 2- or 3- digits numbers are accomplished by using the basic facts of these operations for 1 digit numbers and to know and use them in column form.

c. To know about the simple properties of addition and subtraction and to use them for the purposes of devising algorithms or checking their results.

(3) To enable children to understand the meaning of multiplication and to use it.

a. To know about the cases in which multiplication may be applied, to represent them by mathematical expressions, and to interpret them.

b. To know about the way of increase in the product when the multiplier increases one by one and the commutative law as the properties of multiplication and to use them in constructing multiplication table and checking the results of comput

ing.

c. To know about the multiplication table and to be able to correctly multiply 1-digit numbers.

(4) To enable children to concisely represent the affairs or the relations of quantities in a form of mathematical expression, for example, to represent equivalence and order relations among quantities by using equality or inequality signs, and to interpret them.

B. Quantities and Measurements

(1) To enable children to gradually understand the concepts of length and volume, and to measure these quantities in simple cases.

a. To understand the meaning of the units and the measurements of length and volume.

b. To know about the units (millimeter(mm), centimeter(cm), and meter(m)) to be used in measuring length.

c. To know about the units (milliliter (ml), deciliter(dl) and liter(l)) to be used in measuring volume.

(2) To enable children to gradually understand the concept of time and to use them.

a. To know about day, hour and minute and understand their mutual relations.

C. Geometrical Figures

(1) To enable children to consider the shapes of objects through concrete manipulation and gradually understand the concepts of fundamental geometrical figures.

a. To know about the elements that compose the geometrical figures through experiences in observing and making the objects which have the shape of box.

b. To know about triangles and quadrilaterals by paying attention to the elements that compose the geometrical figures.

c. To know about squares, rectangles and right angled triangles and to draw and make them.

【 Terms / Symbols 】

unit, straight line, right angle, ×, >, <

3. Remarks concerning Content

(1) As for the content A-(1)-e, it is necessary for children to become able to represent affairs in the form of tables or graphs by arranging objects and to interpret these

tables or graphs.

(2) As for the content A-(2)-b, it is necessary to help children consider the way of computing and check the results of computing on the basis of their estimation of the results.

(3) As for the content A-(2) and -(4), parentheses ( ) and a frame ☐ may be used, if necessary.

(4) As for the content C-(1)-c, it is necessary to help children understand that squares and rectangles are frequently used around them as well as to help children enrich their experiences basic to understand the concept of plane extention through manipulative activities such as tessellation.

[3 rd grade]

1. Objectives

(1) To help children become able to use decimal fractions and common fractions to represent the size of quantities. Furthermore, to help them understand the meanings of multiplication and division of whole numbers and become able to compute in basic calculations, as well as to help children appreciate their usefulness and become able to apply them exactly and efficiently according to their purposes.

(2) To help children understand the concepts of weight and time and become able to measure the fundamental quantities such as length through appropriately choosing units and tools according to their purposes.

(3) To help children deepen their understanding of fundamental geometrical figures and become able to construct and use them.

(4) To help children become able to arrange data, and use mathematical expressions and graphs, and to help children appreciate their meaning and become gradually able to represent or investigate the sizes of quantities and their mathematical relations.

2. Content

A. Numbers and Calculations

(1) To enable children to deepen their understanding of whole numbers and the way of representing them.

a. To know about the place of ten thousands ("man" in Japanese pronunciation).

b. To know about the sizes of 10 times, 100 times, $\frac{1}{10}$ of a whole numbers and how to represent them.

c. To deepen their understanding of the relative size of numbers.

(2) To enable children to more surely carry out addition and subtraction of whole numbers and to develop their abilities to use them.

a. To utilize the properties of addition and subtraction for considering how to compute and check the results of computing.

(3) To enable children to deepen their understanding of the multiplication of whole numbers and to develop their abilities to use them.

a. To understand that multiplication of 2- or 3- digits number by 1- or 2- digits number is based on the multiplication table and the properties of operations. Furthermore, to know about the column form of multiplication and to be able to use it.

b. To know about the variation in the product when the multiplier increases one by one and commutative and associative laws as the properties of multiplication and, to use them in considering the way of computation and checking the results of computing.

(4) To enable children to understand the meaning of division and to use it.

a. To know about the case in which division may be applied, to represent them in mathematical expressions and to interpret them.

b. To understand the relations between division and multiplication and between division and subtraction, and to use these relations in formulating mathematical expressions, or calculating and checking the results of computing. Furthermore, to know about the meaning of remainder in division.

c. To know about the column form of division by 1-digit divisor and to use it.

(5) To enable children to understand decimal fractions and common fractions in simple cases and appropriately use them, thereby to gradually appreciate their significance.

a. To use the decimals or fractions to represent the size of fractional parts or size of parts induced by equally dividing. Furthermore, to know about the notations of decimals and fractions.

b. To know that addition and subtraction can be also applied to decimals and fractions.

(6) To enable children to know how numbers are set on the abacus ("soroban" in Japanese pronunciation) and to use it in simple addition and subtraction.

a. To know how to set numbers on the abacus.

b. To know how to add and subtract with the abacus.

B. Quantities and Measurements

(1) To enable children to gradually understand the concept of weight and to measure it.

a. To understand the meaning of unit of measure for weight and of measurement in weight.

b. To know about the units (gram(g) and kilogram(kg)) to be used in measuring weight.

(2) To enable children to measure the length through appropriately choosing units and tools according to their purposes.

a. To know about the unit (kilometer (km)) to be used in measuring distance (length).

b. To estimate length and to concisely represent it by using appropriate units.

(3) To enable children to deepen their understanding of the concept of time, and, in simple cases, to get necessary time and number of hours by computation.

C. Geometrical Figures

(1) To enable children to deepen their understanding of fundamental geometrical figures and to construct or use them.

a. To know about isosceles and equilateral triangles and gradually pay attention to their relation through construction etc.

b. To know about angles in relation to fundamental geometrical figures.

c. To know about center, diameter and radius of a circle. Furthermore, to know about sphere and its diameter etc. in relation to the circle.

D. Quantitative Relations

(1) To enable children to gradually represent relations between quantities by mathematical expressions, to interpret those expressions and to appreciate its significance.

a. To represent a quantitative relation in a formula and interpret it.

b. To represent quantities by using a frame □ and to investigate the values to be filled in it.

(2) To enable children to plainly represent data in simple tables or graphs and to

interpret them.

a. To classify and arrange data from such simple view points as day, time or place, and to represent them in a table.

b. To know how to interpret and draw bar-graphs.

【 Terms / Symbols 】

whole number, number line, decimal point, place of $\frac{1}{10}$ (tenth), numerator, denominator, second, sign of equality, sign of inequality, ÷

3. Remarks concerning Content

(1) As for the content A-(2), -(3) and -(4), it is necessary to help children carry out simple computations mentally.

(2) As for the fundamental geometrical figures in the content C-(1), such activities as drawing and checking the figures with a ruler and compasses should be emphasized as well as it is necessary to help children become interested in beauties which pertain to the figures, through concrete activities such as drawing patterns based on triangles and circles.

(3) As for the content D-(2), in the teaching of graph, it is necessary to help children gradually become able to read minimum scales graduated by 2, 5 or 20, 50 etc.

[4 th grade]

1. Objectives

(1) To help children deepen their understanding of whole numbers and how to express decimal fractions and common fractions as well as understand the meaning of round numbers and become able to use it according to their purposes. Furthermore, to help them become able to master the four basic operations with whole numbers and effectively apply to consideration of phenomena and use addition and subtraction of decimals and fractions.

(2) To help children understand the concept of area and become able to measure the area of simple geometrical figures, and become able to measure the size of an angle.

(3) To help children consider geometrical figures by paying attention to the elements that compose them and their positional relationship and deepen their understanding of the fundamental geometrical plane figures, and also, become able to understand the fundamental solid figures and how to represent the position of

objects.

(4) To help children become able to represent or consider quantities and their mathematical relations by using mathematical expressions or graphs, and further, to help them become able to investigate dependence relation between them according to their purposes and classify and arrange them.

2. Content

A. Numbers and Calculations

(1) To enable children to further deepen their understanding that whole numbers are represented by the decimal positional numeration system.

a. To know about the units such as hundred million ("oku" in Japanese pronunciation), trillion(U.S. etc., billion (U.K. etc.), "chou" in Japanese pronunciation) etc. and to summarize the decimal positional numeration system.

(2) To enable children to understand round number and to use it according to their purposes as well as to appreciate the meaning.

a. To know about the cases in which round numbers may be used.

b. To understand the meaning of rounding, or counting a fraction of 0.5 and over as one and disregarding the rest.

c. To represent the results of computing as round numbers according to their purposes and estimate the sum or difference in round numbers.

(3) To enable children to more accurately compute the multiplication of whole numbers and to develop their abilities of using it.

(4) To enable children to deepen their understanding of the meaning of division of whole numbers and to develop their abilities of using it.

a. To know that division is possible even when the divisor is a 2-digits number and to understand how to carry out the computation.

b. To summarize the following relation: (dividend) = (divisor) × (quotient) + (remainder)

c. To know that the quotient is not changed if divisor and dividend are multiplied or divided by the same number as the property regarding division and use it in considering how to carry out the computation and checking the results of computing.

(5) To enable children to deepen their understanding of the meaning of decimal fractions and to compute in decimals.

a. To know that the system of representation of decimals is the same as of whole

numbers as well as deepen the understanding of relative size of numbers.

b. To be able to add and subtract in decimals.

c. To be able to carry out multiplication and division in the cases where the multiplier and divisor are whole numbers.

(6) To enable children to deepen their understanding of the meaning of fractions and to compute in fractions in simple cases.

a. To deepen their understanding of the representation of fractions and their meanings. Furthermore, in simple cases to pay attention to the fact that there are equivalent fractions.

b. To be able to add and subtract in fractions with the common denominator.

(7) To enable children to summarize their understanding of the meanings and properties of the four fundamental operations and to adequately use them, and thereby to apply and check the operations in concrete situations.

a. To summarize their understanding of the cases in which the four operations may be used and the mutual relations among them.

b. To pay attention to the fact that how to compute is based on the commutative, associative and distributive laws.

(8) To enable children to add and subtract with the abacus ("soroban").

B. Quantities and Measurements

(1) To enable children to understand the concept of area and to measure the area in simple cases.

a. To understand the meaning of unit and measurement in area.

b. To know about the units (square centimeter(cm^2), square meter(m^2), square kilometer(km^2), are(a) and hectare(ha)) to be used in measuring area.

c. To know how to measure the area of squares and rectangles.

(2) To enable children to deepen their understanding of the concept of angle and to measure it.

a. To know the unit degree(°) to be used in measuring angle.

b. To understand the meanings of half rotation and full-rotation etc.

C. Geometrical Figures

(1) To enable children to deepen their understanding of the fundamental plane figures through observing and constructing geometrical figures, and further, to consider geometrical figures by paying attention to their elements that compose them and

positional relations.

a. To understand the relations such as parallelism and perpendicularity of lines.

b. To know about parallelograms,trapezoids and rhombuses etc.

c. To pay attention to mutual relation among quadrangles through construction.

(2) To enable children to understand fundamental solid figures through observing, composing and decomposing geometrical figures, and to consider the space in simple cases.

a. To understand a cube and a rectangular parallelopiped.

b. To understand parallelism and perpendicularity of lines and planes in connection with the rectangular parallelopiped.

(3) To enable children to understand how to represent the position of an object in space.

D. Quantitative Relations

(1) To enable children to gradually represent and investigate the relations between two quantities which vary in company with each other.

a. To investigate the quantitative relations in simple cases by considering the corresponding quantities or by representing the ordered pairs of corresponding values in a table.

b. To represent how the quantities are varying in a broken line graph and to interpret the features of their variation.

(2) To enable children to concisely represent mathematical relations in quantitative expressions and interpret those expressions.

a. To understand the meanings of the expressions with the some of four operations and those with parentheses ( ), and to correctly compute.

b. To understand the idea of formula and to use it.

c. To represent variable quantities by using frames □, △, to represent the relation in mathematical expressions and to investigate the values to be filled in them.

(3) To enable children to develop their abilities to gather, classify and arrange data according to their purposes and to investigate their features.

a. To investigate all possible cases as regards two affairs.

b. To check up on omissions and duplications in data.

c. To represent the data in broken-line graph etc., and to investigate the features and tendencies from these graphs.

【 Terms / Symbols 】

sum, difference, product, quotient, mixed fraction, proper fraction, improper fraction, parallel, perpendicular, diagonal line, plane

3. Remarks concerning Content

(1) As for the content A-(3) and -(4), in cases where the multiplier or divisor is 3-digits number, it is necessary to guide children to devise algorithms in a similar manner as the algorithms with 2-digits multiplier or divisor. Complex calculations should be avoided.

(2) As for the content A-(5)-c, the cases in which a whole numbers is divided by a whole number and the quotient is decimal should be included.

(3) As for the content C-(2), it is necessary for children to become able to draw simple sketchmaps and development figures as an occasion demands and to gradually appreciate the significance of representing a solid geometrical figures in a plane.

[5 th grade]

1. Objectives

(1) To help children understand the meanings of multiplication and division of decimal fractions and become able to compute in decimals and fractions, as well as become able to make use of them in considering phenomena. Furthermore, to help them deepen their understanding of the concept of whole numbers.

(2) To help children become able to measure the area of fundamental geometrical plane figures, and further, to help them understand the concept of volume and become able to measure the volume of simple geometrical figures. And also to help children become able to understand the concept of speed and measured values.

(3) To help children understand the meaning of congruence and become able to consider fundamental geometrical figures by paying attention to the elements that compose them.

(4) To help children become able to concisely represent the mathematical expression by using letters, and to investigate the mathematical relations represented by them. Furthermore, to help them become able to consider statistical data by using percentage and circle graph.

2. Content

A. Numbers and Calculations

(1) To enable children to deepen their understanding of whole numbers.

a. To know that the set of whole numbers may be classified into some subsets such as odd numbers and even numbers if some viewpoints are determined.

b. To know about divisors and multiples.

(2) To enable children to deepen their understanding of both whole numbers and decimal fractions from the standpoint of numeration system and to efficiently use this property in computation.

a. To make the multiples of a number multiplied by 10, 100, $\frac{1}{10}$ or $\frac{1}{100}$ by moving the decimal point.

(3) To enable children to deepen their understanding of the meaning of multiplication and division in decimal fraction and to develop their abilities to use them.

a. To summarize the meaning of multiplication and division, including the case in which the multiplier and divisor are decimal fractions.

b. To know how to carry out multiplication and division of decimal fractions.

c. To understand that the same relations and rules for multiplication and division of whole numbers also apply to decimal fractions.

(4) To enable children to deepen their understanding of the meaning of fractions and to develop their abilities to compute with fraction.

a. To transform fractions into decimals and to represent whole numbers and decimals as fractions .

b. To understand that the value of a fraction is not changed when both its numerator and denominator are multiplied or divided by the same number.

c. To summarize the methods for comparing fractions by size.

d. To be able to carry out addition and subtraction of fractions having different denominators.

e. To know that the result of division of whole numbers can be always represented as a single number by using fractions.

(5) To enable children to develop their abilities to estimate the size of a product or a quotient by using round numbers according to their purposes.

B. Quantities and Measurements

(1) To enable children to deepen their understanding that the area of fundamental geometrical plane figures may be found by computation and to develop their

abilities to measure the area.

a. To know how to find the area of triangles, parallelograms and trapezoids etc.

b. To find the area of a polygon by decomposing it into triangles or others.

c. To know about the area of a circle.

(2) To enable children to understand the concept of volume and to measure the volume in simple cases.

a. To understand the meaning of unit of volume and of measurement.

b. To know about the units (cubic centimeter(cm^2) and cubic meter(m^2)) to be used in measuring volume.

c. To know how to measure volume of a cube and a rectangular parallelopiped.

d. To understand the meaning of capacity.

(3) To enable children to deepen their understanding of estimating the sizes of quantities by rough measurement and of the meaning of measured values.

a. To approximate a given figure by fundamental figures and to roughly estimate their length, area or volume from such approximation.

b. To understand the meaning of the average and to use it.

(4) To enable children to understand how to compare and express the quantity which may be represented as the ratio of two different kinds of quantities and to use it.

a. To use the idea of "per unit".

b. To understand the meaning of speed and its way of representation and to calculate speed.

C. Geometrical Figures

(1) To enable children to further deepen their understanding of fundamental plane figures through observing and constructing geometrical figures.

a. To understand congruence of geometrical figures and the correspondence of vertices, sides and angles etc. in congruent figures.

b. To gradually pay attention to elements to determine shape and size of a geometrical figure.

c. To investigate and construct geometrical figures by finding the simple properties of fundamental figures.

d. To understand the meaning of the ratio of the circumference of a circle to its diameter.

e. To draw regular polygons and to investigate their fundamental properties by using circles.

D. Quantitative Relations

(1) To enable children to understand the meaning of percentage and to use it.

(2) To enable children to deepen their understanding of the way of viewing or investigating the quantitative relations represented by simple expressions by paying attention to the correspondence between two quantities and or to the aspect of variation.

(3) To enable children to represent the relation or law between quantities more concisely and generally with mathematical expressions and to interpret them.

a. To know that the relation represented by a formula holds true, whether involved numbers are whole numbers or decimal fractions.

b. To know that the letters such as a, x etc., may be used instead of frames, □, △ or the words standing for quantities and investigate them by substituting numbers to them.

(4) To enable children classify and arrange data according to their purposes, and to represent data by using circle graphs and tape graphs.

【 Terms / Symbols 】

reduction, reduction to a common denominator, greatest common divisor, least common multiple, congruence, sector, central angle, %

3. Remarks concerning Content

(1) As for the content A-(1)-b, it is necessary for teaching the greatest common divisor and the least common multiple to base on concrete situations, and not to bias to formal computation.

(2) As for the content B-(1)-c and C-(1)-d, though 3.14 is used as the circular constant, it is necessary to guide children to become able to deal with the situations by using 3 according to their purposes.

(3) As for the content C-(1), it is necessary to emphasize manipulative activities such as tessellation of plane by congruent figures.

(4) As for the content D-(1), it is necessary to simply allude to the meaning of the ratio based on 10 percent ("buai" in Japanese pronunciation).

(5) As for the content D-(3) b, when using letters such as a, x the understanding of the meaning represented by such letters should be stressed. However, the teaching should be restricted to the extent to make children familiar with expressions letters.

[**6 th grade**]

1. Objectives

(1) To help children understand the meaning of multiplication and division of fractions and become able to use them as well as to help them deepen their understanding of multiplication and division in general.

(2) To help children become able to measure the volume of fundamental solid figures. Furthermore, to help children know about the system of units of measuring and become able to efficiently measure the quantities.

(3) To help children consider geometrical figures from a view point of the symmetry and to help them more thoroughly deepen their understanding of the geometrical figures.

(4) To help children deepen their idea of function through their understanding of proportion and become able to efficiently use it in considering quantitative relations. Furthermore, to help children become able to statistically consider and represent by investigating the distribution of data etc.

2. Content

A. Numbers and Calculations

(1) To enable children to understand the meaning of multiplication and division of fractions and to use them, as well as to deepen their understanding of multiplication and division in general.

a. To summarize the meaning of multiplication and division, including the cases in which the multiplier or the divisor is a whole number or a fraction.

b. To know how to multiply and divide in fractions.

c. To regard division as multiplication by the reciprocal.

d. To integrate multiplication and division of whole numbers and decimals respectively into those of fractions. Furthermore, to represent a number expressed by multiplication and division as a fractional form.

B. Quantities and Measurements

(1) To enable children to measure the volume of fundamental solid figures through experiments and actual measurement, etc.

a. To know how to measure the volume and surface area of fundamental prisms

and circular cylinders.

b. To know how to measure the volume of fundamental pyramids and circular cones. Furthermore, to know how to measure their surface area in simple cases.

(2) To enable children to deepen their understanding of the measurements and units of quantities and to further develop their abilities to measure.

a. To efficiently measure by using the proportional relationships.

b. To understand the metric system and relations among their units and to efficiently use them in measurement.

C. Geometrical Figures

(1) To enable children to further deepen their understanding of plane figures.

a. To understand the meaning of line and point symmetry, and to consider the fundamental figures from the viewpoint of symmetry.

b. To summarize their understanding of shapes and size of the figures, and to interpret and draw simple scale drawings.

(2) To enable children to deepen their understanding of the fundamental solid figures through manipulation such as composition and decomposition.

a. To know about the fundamental prisms and circular cylinders.

b. To know about the fundamental pyramids and circular cones.

D. Quantitative Relations

(1) To enable children to understand the meaning of ratio and to use it.

(2) To enable children to develop their abilities to consider relations between two quantities which vary in company with each other.

a. To understand the meaning of direct proportion. Furthermore, to investigate its features by using mathematical expressions and graphs in simple cases.

b. To understand the meaning of inverse proportion. Furthermore, to represent it by using mathematical expressions.

c. To know that there are many cases which may be efficiently treated by paying attention to the proportional relation.

(3) To enable children to develop their abilities of statistically considering and representing by investigating the dispersion of data in simple cases.

a. To know about a table and graph to represent frequency distribution.

b. To know that there is a case in which the tendency of a population is conjectured by the ratios gained from a part of statistical data.

c. To choose adequate tables and graphs according to their purposes and to devise some useful ones.

(4) To enable children to gradually arrange in order and investigate the possible cases concerning simple affairs.

【 Terms / Symbols 】

reciprocal, base, side face, axis of symmetry, center of symmetry, value of ratio, more than or equal to, less than, :

3. Remarks concerning Content

(1) As for the content A-(1), it is necessary to pay attention to allude that the relation represented in a formula is also valid for fractions.

(2) As for the content B-(1)-b, solid figures to be taught should be restricted to such ones as their development figures can be easily drawn, and circular cones to be taught in measuring the surface area should be restricted to those whose side faces are developed to a half circle or a quadrant circle.

(3) As for the content B-(2)-b, kiloliter(kl), milligram(mg) and ton(t) should be simply alluded.

(4) In the teaching on the content B and D, it is necessary to pay attention to use letters such as a, x and help children become familiar with them.

(5) As for the content C-(2), interpreting and drawing such figures as sketchmaps and development figures, and vertical planes and ground plans in simple cases should be taught as an occasion demands.

(6) As for the content D-(2), it should be treated in following manners :

a. In teaching graphs of direct proportion in (2)-a, consideration should be given to help children gradually pay attention to continuous changes and the domain.

b. In teaching inverse proportion in (2)-b, the feature of variation of two quantities may be alluded only by using broken-line graph.

III. THE CONSTRUCTION OF TEACHING PLANS AND REMARKS CONCERNING CONTENT IN EACH GRADE

1. When constructing teaching plans, the following points should be considered :

(1) The content of each grade in II must continue to be taught in the following

grades, in case of necessity.

(2) As much of the content in each domain of II may be efficiently used in the teaching of other domains, it should be designed to teach the content of each domain so as to well relate each other.

(3) For mastering and maintaining the fundamental skills such as calculation and measurement, the opportunity to exercise them should be intentionally provided as an occasion demands.

(4) As regards numbers, quantities and geometrical figures, the teacher should help children become able to grasp rough size and approximate shape, adequately judge and think out how to efficiently cope with them based on them.

2. As to the content of II, the following points should be considered :

(1) The teacher should suitably provide the situation in which children think for themselves, and help them become able to carry out activities such as concrete manipulation and thought experiments suitable for their developmental levels and states of achievement in learning, and the teacher should gradually foster their abilities of logical thinking and of intuition.

(2) Terms and symbols indicated in each grade are for the purposes of clarifying the extent and the range of content dealt with in the respective grades, and for teaching those terms and symbols, it is necessary to deal with them in relation to the content of each grade and to help children appreciate the significance of using them in their representing and thinking.

(3) In the lower grades, the teacher should carefully pay attention to the relationships of this subject with various experiences in daily-life, while emphasize the process of abstracting numbers, quantities and geometrical figures from concrete objects and their manipulation, and help children become interested in and familiar with numbers, quantities and geometrical figures.

(4) On the teaching of the units in B, the teacher should help children enrich their sense of quantities, and become able to grasp approximate shapes, adequately choose the units and cope with, as well as the teacher should not bias toward formal conversion of units.

(5) On the teaching of computation in decimals and fractions in A, the teacher should avoid complex computations and assure for children to understand the meaning of

computation and how to compute.

(6) At the fifth grade or later, the teacher should help children adequately use "soroban" or hand-held calculators, for the purposes of lightening their burden to compute and of improving the effectiveness of teaching, in situations where many large numbers to be processed are involved for statistically considering or representing, or where they confirm whether the laws of computation still hold in multiplication and division of decimal fractions. At that time, the teacher should pay attention to provide adequate situations in which the results of computation may be estimated and computation may be checked through rough estimation.

CURRICULUM OF MATHEMATICS FOR THE LOWER SECONDARY SCHOOL

Revised by the Ministry of Education in 1989, and to be put in force beginning in 1993.

Excerpt from the General Provision of the Course of Study for the Lower Secondary School

1. Mathematics is a required subject in each grade.
2. Standard numbers of class periods per year required for Mathematics are prescribed as follows:

1st grade	(12 years old)	105
2nd grade	(13 years old)	140
3rd grade	(14 years old)	140

3. Mathematics is one of several optional subjects at the 3rd grade.

Notes :

1) Each class period is 50 minutes long.
2) Lessons on Mathematics must be given over at least 35 weeks a year.
3) Number of class periods for mathematics as an optional subject at the 3rd grade is at most 35 periods per year, in addition to mathematics as a required subject.

Mathematics

I. OBJECTIVES

The aims are to help students deepen their understanding of the basic concepts, principles and rules concerning numbers, quantities and figures, and acquire the way of mathematically representing and coping with, and to enhance their abilities of mathematically considering things, as well as to help them appreciate the mathematical way of viewing and thinking, and thereby to foster their attitudes of willingly applying them.

II. OBJECTIVES AND CONTENT IN EACH GRADE

[1 st Grade]

1. Objectives

(1) To help students deepen their understanding of the concept of numbers, through the enlarging of the scope of numbers to include positive and negative numbers. Furthermore, to help them understand the significance of using letters as symbols and the meaning of equation, and to help students become able to represent relations among quantities and the rules generally and briefly and handle them.

(2) Through manipulation and experiments, of plane and solid geometrical figures, to help students deepen an intuitive way of viewing and thinking those figures, and thereby to foster the foundation for logically considering.

(3) To help students deepen their views and concepts of changes and correspondence, and understand functional relations, and develop their abilities to represent and use them.

2. Content

A. Numbers and Algebraic Expressions

(1) To enable students to understand the meaning of positive and negative numbers, and to compute with those numbers according to four fundamental operations.

(2) To enable students to develop their abilities to represent relations and rules in a formula by use of letters, and to calculate simple expressions.

a. The use of letters as symbols.

b. The way of representing multiplication and division in an algebraic expression by using letters.

c. Addition and subtraction of linear expressions.

(3) To enable students to understand the meaning of equation, and to apply linear equations.

a. The meaning of letters and solution in an equation.

b. The properties of equality.

c. To solve linear equations with one variable.

【 Terms/Symbols 】

natural number, sign, absolute value, term, coefficient, $\leqq$, $\geqq$

B. Geometrical Figures

(1) To enable students to develop their abilities to insightfully construct figures that meets given conditions, and thereby deepen their understanding of plane figures.

a. To construct basic figures such as the bisector of an angle, perpendicular bisector of a line segment, perpendicular, etc.

b. Translation, symmetry and rotation.

c. To consider a figure as a set of points that meet certain conditions, and to construct the figure.

(2) To enable students to consider geometrical figures through various manipulation and to deepen their understanding of figures in space.

a. Positional relations between straight lines and planes in space.

b. Construction of solid geometrical figures by movement of plane figures.

c. Section, projection and development of solid geometrical figures.

[Terms/Symbols]

arc, chord, solid of revolution, π, $/\!/$, $\perp$, $\angle$, Δ

C. Quantitative Relations

(1) To enable students to understand the functional relation, through extracting two quantities – varying in company with each other – from phenomena, considering the relationship between them and clarifying its characteristics.

a. Variation and Correspondence.

b. The meaning of coordinates.

c. To represent a functional relation in table, graph, and formula, etc.

(2) To enable students to develop their abilities to consider and represent mathematical relationships, through deepening of their understanding of the characteristics of algebraic expressions and graphs of direct and inverse proportions.

[Terms/Symbols]

variable, domain

3. Remarks concerning Content

(1) As for the content A-(1), the applicability of four fundamental operations should be taught.

(2) As for the content A-(2)-c, the computations of algebraic expressions should be limited to the level needed in solving linear equations.

(3) As for the content B-(2)-c, the teacher should not go too far into a technical and

applied aspects of the section and projection.

(4) As for the content C-(2), correctly drawing graphs should be included.

[2 nd Grade]

1. Objectives

(1) To help students develop their abilities to compute and transform algebraic expressions using letter symbols according to their purposes, and to help them understand linear inequalities and simultaneous equations, and to foster their abilities to use them.

(2) To help students deepen their understanding of the properties of the fundamental figures in a plane, and thereby understand the significance and methods of mathematical inference with reference to consideration of the properties of figures, and to foster their abilities to precisely represent the process of inference.

(3) To help students further deepen the way of viewing and thinking variation and correspondence and understand the characteristics of linear functions ,and foster their abilities to use them. Furthermore, to help students adequately represent numbers according to their purposes and develop their abilities to grasp the tendencies of statistical phenomena.

2. Content

A. Numbers and Algebraic Expressions

(1) To enable students to carry out the four fundamental operations of simple algebraic expressions using letters .

a. Addition and subtraction of simple polynomials.

b. Multiplication and division of monomials.

(2) To enable students to develop their abilities to find the quantitative relationships in phenomena, and to represent such relationships in an algebraic expression by using letters and to utilize them.

a. To make use of algebraic expressions.

b. To transform simple equalities.

(3) To enable students to understand the meaning of inequality and to apply linear inequalities.

a. Inequality and the meaning of its solution.

b. The properties of inequality.

c. To solve linear inequalities.

(4) To enable students to understand the meaning of simultaneous linear equation and their solution, and thereby to apply them.

a. The meaning of linear equation with two variables and its solution.

b. To solve simple simultaneous linear equations.

【 Terms/Symbols 】

similar term

B. Geometrical Figures

(1) To enable students to find the properties of a figure in a plane, and confirm them by using the properties of parallel lines and the conditions for congruence of triangles.

a. The properties of parallel lines.

b. The conditions for congruence of triangles.

c. The properties of triangles and parallelograms.

(2) To enable students to clarify the concepts of similarity of figures, and develop their abilities to find the properties of figures by using the conditions for congruence or similarity of triangles and confirm them.

a. The meaning of similarity and the conditions for similarity of triangles.

b. The properties of the ratio of segments of parallel lines.

c. The applications of similarity.

【 Terms/Symbols 】

opposite angle, interior angle, exterior angle, definition, proof, center of gravity, $-$, ∞

C. Quantitative Relations

(1) To enable students to deepen their understanding of representation of numbers and to adequately use numbers in real situation.

(2) To enable students to further deepen their understanding of functional relations, understand the characteristics of linear functions and develop their abilities to make use of it.

a. Some phenomena may be represented by use of linear functions.

b. The ratio of changes in the values of linear function and characteristics of the graph.

c. A linear equation with two variables may be considered to represent the functional relationships between two variables.

(3) To enable students to collect data according to their purposes, arrange these data by using tables and graphs, and thereby to ascertain the tendencies of the data by paying attention to representative values and dispersion etc.

a. The meaning of frequency distribution and how to interpret of histogram.

b. The meaning of relative frequency.

c. The meaning of mean value and range.

d. How to interpret correlation diagrams and tables.

【 Terms/Symbols 】

significant figure, approximate value, error, frequency, class

3. Remarks concerning Content

(1) As for the content A-(3), representing procedure for computation such as flow chart should be also included.

(2) As for the content A-(4)-b, simultaneous linear equation with two variables should be taught.

(3) As for the content B-(2)-c, measurement of height and distance as applications of similarity should be taught.

(4) As for the content C-(1), numeration system such as binary system and expression in the form of $a \times 10^n$ should be taught.

(5) As for the content C-(3), attention should be paid to the teaching based on the real situation concerning daily-life phenomena.

[3 rd Grade]

1. Objectives

(1) To help students understand the square root of numbers, and thereby further deepen their understanding of the concept of numbers. Furthermore, to help students understand the transformation of algebraic expressions according to their purposes and quadratic equations, further deepen their understanding of algebraic expressions, and thereby efficiently deal with them.

(2) To help students deepen their understanding of the properties of right triangles and circles, and develop their abilities to use them in considering the properties of figures and in measuring them. Furthermore, to help them develop their abilities

to consider figures logically and insightfully.

(3) To help students further develop to represent or to use functional relations, and deepen their understanding of the functions through investigating the characteristics of functions. Furthermore, to help students understand the meaning of probability and the elementary concepts of sampling survey, and thereby deepen their views and way of statistical thinking.

2. Content

A. Numbers and Algebraic Expressions

(1) To enable students to understand the meaning and necessity of square root of the positive numbers, and use them.

a. The meaning of the square root of numbers.

b. Computation of simple algebraic expressions involving square roots.

(2) To enable students to expand and factor an expression with regard to simple polynomials using letters.

a. Multiplication of a monomial and a polynomial and division of a polynomial by a monomial.

b. Multiplication of simple linear expressions.

c. Expansion and factorization of an expression by using the formulae below :

$(a+b)^2=a^2+2ab+b^2$

$(a-b)^2=a^2-2ab+b^2$

$(a+b)(a-b)=a^2-b^2$

$(x+a)(x+b)=x^2+(a+b)x+ab$

(3) To enable students to understand quadratic equations and their solution, and apply them.

a. Quadratic equations and their solution.

b. To solve quadratic equations by using factorization and the formulae for solution, etc.

【 Terms/Symbols 】

radical sign, rational number, irrational number, prime number, factor, $\sqrt{\ }$

B. Geometrical Figures

(1) To enable students to deepen their understanding of the properties of circles and consider the properties of figures by using them.

a. The properties of a circle and a straight line and the properties of two circles.

b. Relationship between the angle of circumference and the central angle.

(2) To enable students to understand the measuring properties of figures and use them.

a. The Pythagorean theorem and its applications.

b. Length of an arc and area of a sector, and surface area and volume of a sphere.

c. Similarity of simple solid figures, and the relationships between the ratios of length, area, and volume in similar figures.

【 Terms/Symbols 】

tangential line, point of tangency

C. Quantitative Relations

(1) To enable students to develop their abilities to investigate the characteristics of change or correspondence by extracting two quantities in functional relations from a phenomena.

a. Various phenomena and their functions.

b. Function $y = ax^2$.

c. The ratio of change in the value of function.

(2) To enable students to understand the probability by paying attention to the frequency obtained through large numbers of observations or trials.

a. Stochastic events and the meaning of probability.

b. To compute probability in simple cases.

(3) To enable students to understand that the tendencies in a population can be estimated from a sample.

3. Remarks concerning Content

(1) As regards the content A (2) etc., factorization of a natural number into prime factors should be also included.

(2) As for the content A-(3)-b, only quadratic equations having the real solution should be taught. And, in using factorization as a solving method, the available formulae should be limited to the ones indicated in A-(2)-c.

(3) As for the content C-(2)-b, events which may be easily classified by the aid of tree diagrams, etc. should be dealt with.

(4) As for the content C-(3), attention should be paid to dealing with it through experiments and observation.

III. THE CONSTRUCTION OF TEACHING PLANS AND REMARKS CONCERNING CONTENT

1. Without disturbing to achieve the objectives of the each grade in II, the teachers may lightly refer to a part of the content for the proper grade and give full instruction to it in a succeeding grade. Whereas, without deviating from the objectives of the grade, the teachers may also include a part of the content assigned to a higher grade in their instruction.
2. In the 2nd and 3rd grades, problem situation learning should be included in a total teaching plan with an appropriate allotment and implement for the purpose of stimulating students' spontaneous learning activities and of fostering their views and ways of thinking mathematically. Here, 'problem situation learning' means the learning to cope with a problem situation, appropriately provided by the teacher so that the content of each domain may be integrated or related to daily affairs.
3. The items indicated in terms and symbols of the content for each grade in II are shown to clarify the extent and range of the content dealt with in each grade. In teaching them, the teachers should deal with them in close relation with those content.
4. In the teaching of each domain, computers should be efficiently utilized as an occasion demands. In particular, this matter need to be considered in the instruction by the experiment and observation etc. in "Quantitative Relations".
5. In the teaching of numerical computation, the teacher should give consideration to improve the effectiveness of learning by having the students use "soroban" (Japanese abacus), or hand-held calculators etc. as an occasion demands.
6. In "mathematics" as an optional subject in the 3rd grade, the learning activities such as problem situation learning, field or laboratory work, experiment, and investigation on the content should be appropriately designed and dealt with in school so as to develop various learning activities in accord with students' characteristics.

CURRICULUM OF MATHEMATICS FOR THE UPPER SECONDARY SCHOOL

Revised by the Ministry of Education in 1989, and to be put in force beginning in 1994.

Excerpt from the General Provision of the Course of Study for the Upper Secondary School

1. Mathematics in the upper secondary school is composed of several subjects whose titles and associated credits are shown in the following table.

Subject	Standard Number of Credits
Mathematics I	4
Mathematics II	3
Mathematics III	3
Mathematics A	2
Mathematics B	2
Mathematics C	2

2. Mathematics I is required for all students, but the other Mathematics subjects are optional.

Note:

1) One credit consists of 35 class hours and a class periods of 50 minutes is defined as one class hour.

MATHEMATICS

〔I〕 OVERALL OBJECTIVES

To help students deepen their understanding of basic concepts, principles and laws of mathematics, and develop their abilities to think and cope with mathematically in dealing with various phenomena, and appreciate mathematical way of viewing and thinking, and thereby to foster their attitudes which encourage the use of such abilities.

【II】 SUBJECTS

I. Mathematics I

1. Objectives

Through consideration of concrete phenomena, to help students understand quadratic functions, geometrical figures and mensuration, treatment of numbers of cases and probability, and to encourage them to master basic knowledge and skills, to develop their abilities to utilize them exactly and to deepen their appreciation of significance of mathematical way of viewing and thinking.

2. Content

(1) Quadratic Functions

a. Quadratic function and its graph

(i) function and its graph

(ii) quadratic function and its graph

b. Variation of values of quadratic function

(i) maximum and minimum of quadratic function

(ii) quadratic equation and quadratic inequality

(2) Geometrical Figures and Mensuration

a. Trigonometric ratios

(i) sine, cosine, tangent

(ii) mutual relations among trigonometric ratios

b. Trigonometric ratios and geometrical figures

(i) sine theorem and cosine theorem

(ii) mensuration of geometrical figures

【Terms/Symbols】 sin, cos, tan

(3) Treatment of Numbers of Cases

a. Rule of enumeration

b. Sequences of natural numbers

c. Numbers of cases

(i) permutation

(ii) combination

【Terms/Symbols】 ${}_nP_r$, ${}_nC_r$, factorial, $n!$

(4) Probability

a. Probability and its basic laws

b. Independent trial and probability

c. Expectation

【Terms/Symbols】 complementary event, exclusiveness

3. Remarks concerning Content

(1) As for the content (1)-b-(ii), quadratic equations should be limited to those with real solutions.

(2) As for the content (2), the range of angles should be from 0° to 180°.

(3) As for the content (2)-b-(ii), the teacher should give instruction to the mensuration of plane and space figures, but should not go too far to the calculation using Heron's formula for area of triangle.

(4) As regards the item indicated in content (3)-a, the teacher should give instruction to counting of number of elements of sets, but those treatments should be limited to simple cases.

(5) As regards the item indicated in content (3), the teacher should give instruction to the fundamental facts of sets.

(6) As for the content (4), the teacher should give instruction to those in relation to examples involving real situations.

(7) As for the content (4)-b, dependent and independent events are not included.

(8) Since "Mathematics I" is the subject for all students, the teachers should consider to treat the level and scope of content flexibly in accord with actual state of students as well as to devise their teaching methods.

II. Mathematics II

1. Objectives

As the content following to "Mathematics I", to help students understand exponential and trigonometric function, geometrical figures and equations, and variation of values of functions and to encourage them to master basic knowledge and skills, and to develop their abilities to think and cope with mathematically in dealing with various phenomena.

2. Content

(1) Various Functions

a. Exponential function

(i) extention of exponent

(ii) exponential function

(iii) logarithmic function

b. Trigonometric function

(i) extention of angle

(ii) trigonometric function and its basic properties

(iii) addition theorems for trigonometric functions

【Terms/Symbols】 power root, $\log_a x$

(2) Geometrical Figures and Equations

a. Points and lines

(i) coordinate of points

(ii) equations of straight lines

b. Circles

(i) equations of circles

(ii) circles and lines

(3) Variation of Values of Functions

a. Differential coefficient and derivatives

b. Applications of derivatives

c. Idea of integration

【Terms/Symbols】 limit value, *lim*, indefinite integral, definite integral

3. Remarks concerning Content

(1) As for the content (1)-a-(iii), computation by logarithms is not included. As for the content (1)-b-(iii), double angle formula and composition of simple harmonic motions are taken up, but should not go too far.

(2) As regards the item indicated in content (2), the teacher should give instruction to the geometric locus and the regions represented by inequalities in simple cases.

(3) As regards the item indicated in content (2)-b-(ii), the teacher should give instruction to the simultaneous equations with two variables of first and second degree.

(4) As for the content (3), the teacher should give instruction to the level of functions of third degree.

(5) As for the content (3)-c, the instruction should be limited to the level of finding areas in relation to graphs of functions.

III. Mathematics III

1. Objectives

To help students deepen their understanding of functions and limits, differential and integral calculus, and to encourage them to master knowledge and skills, and to develop their abilities to think and cope with mathematically in dealing with various phenomena.

2. Content

(1) Functions and Limits

a. Concept of function

(i) rational functions and irrational functions

(ii) composite functions and inverse functions

b. Limits

(i) limits of sequences $\{r^n\}$

(ii) sum of infinite geometrical series

(iii) limits of value of functions

【Terms/Symbols】 convergent, divergent, ∞

(2) Differential Calculus

a. Derivatives

(i) derivatives of sum, difference, product and quotient of functions

(ii) derivatives of composite functions

(iii) derivatives of trigonometric function, exponential function and logarithmic function

b. Applications of derivatives

tangent, increase and decrease of values of function, velocity, acceleration

【Terms/Symbols】 radian measure, natural logarithm, e, the second derivative, point of inflection

(3) Integral Calculus

a. Indefinite integral and definite integral

(i) meaning of integration

(ii) integrations by substitution and by part in simple cases

(iii) integrations of various functions

b. Applications of integration

area, volume and distance

3. Remarks concerning Content

(1) As for the content (1)-a-(ⅰ), functions such as $y=\frac{ax+b}{cx+d}$ and $y=\sqrt{ax+b}$ should be included.

(2) As regards the item indicated in content (2), though the mean value theorem may be allude, the instrnction should be limited to the level of understanding it intuitively.

(3) As for the content (2)-a-(ⅱ), simple functions such as $y=x^k$ (k is rational number), $y=\sqrt{ax+b}$ and $y=\sqrt{ax^2+b}$ should be included.

(4) As for the content (3) a-(ⅱ), integration by substitution should be limited such a level as substitution by $ax+b=t$ or $x=a\sin\theta$. Integration by part should be limited to those cases where only a single application is required concerning simple functions.

IV. Mathematics A

1. Objectives

As a broader content than "Mathematics I", to help students understand numbers and algebraic expressions, plane geometry, sequences or computation using computers, to encourage them to master basic knowledge and skills, and to develop their abilities to think and cope with mathematically in dealing with various phenomena.

2. Content

(1) Numbers and Algebraic Expressions

a. Numbers

integers, rational numbers, real numbers

b. Algebraic Expressions

(i) polynomials

(ii) equalities and inequalities

(2) Plane Geometry

a. Properties of plane geometrical figures

(i) fundamental theorem of plane geometry

(ii) figures determined by conditions

b. Transformation on plane

(i) congruence transformation

(ii) similar transformation

(3) Sequences

a. Sequences and their summations

b. Recurring formula and mathematical induction

c. Binomial theorem

【Terms/Symbols】 Σ

(4) Computation and Computer

a. Operation of computer

b. Flow chart and programing

c. Calculation using computer

3. Remarks concerning Content

(1) In accord with the actual state of students taking this subject, instruction should consist of sections appropriately chosen from content (1) to (4).

(2) As regards the item indicated in content (1)-b, the teacher should give instruction to the proof in algebraic expressions in simple cases.

(3) As regards the item indicated in content (1), content such as necessary condition, sufficient condition, contraposition and reductive absurdity should be included.

(4) As for the content (2)-a, the teaching should be at such a level as to develop their abilities to utilize what students have learned in lower secondary school by basing on and expanding them. As for the content (2)-b, teaching should be limited to the level of reviewing properties of geometrical figures by idea of transformation.

(5) As for the content (3)-a, the teachers should treat it to the level of arithmetic and geometric sequences, and sequences of $\{n^2\}$. As for the content (3)-b, recurring formulae should be limited to those for successive two terms, and the mathematical induction should be taught by putting emphasis on their understanding of its idea, without getting mixed up in its technical detail.

(6) As for the content (4)-b, the teachers should put their emphasis on helping students' understanding of structure of programing, but only short programs should be treated. As for the content (4)-c, use of computer should be at the level of using it for processing those computations which are concerning what students have learned in lower secondary level or "Mathematics I "

V. Mathematics B

1. Objectives

As more advanced content than "Mathematics I" and "Mathematics II", to help students understand vectors, complex numbers and complex number plane, probability distribution, or algorithm using computer, and to encourage them to master basic knowledge and skills, and to develop their abilities to think and cope with mathematically in dealing with various phenomena.

2. Content

(1) Vectors

a. Vectors on a plane

(i) vectors and their operations

(ii) inner product of vectors

b. Vectors in a space

(i) coordinate in space

(ii) vectors in space

(2) Complex Numbers and Complex Number Plane

a. Complex numbers and solutions of equation

(i) complex numbers and their operations

(ii) solutions of quadratic equation

(iii) simple equation of higher degree

b. Complex number plane

(i) geometric representation of complex number

(ii) De Moivre's theorem

【Terms/Symbols】 imaginary number, i, discriminant, argument, polar form

(3) Probability Distribution

a. Calculation of probability

b. Probability distribution

(i) random variable and probability distribution

(ii) binomial distribution

【Terms/Symbols】 conditional probability, mean, standard deviation

(4) Algorithm and Computer

a. Function of computer

b. Program of various algorithms

3. Remarks concerning Content

(1) In accord with the actual state of students taking this subject, instruction should consist of sections appropriately chosen from content (1) to (4).

(2) As for the content (1)-b (ii), the teacher should emphasize students' understanding that vectors in a space may be analogeously dealt with vectors on a plane, and should not get mixed up in detail of the equations of solid figures.

(3) As for the content (2)-a (iii), teaching should be restricted to such level that students understand application of factor theorem to the equations of third order and fourth order with simple coefficient. As for the content (2)-b, teaching should be restricted to applications to simple binomial equations and to plane figures, and not get mixed up in its technical detail.

(4) As for the content (3) a, calculation of probability should be restricted to the level of conditional probability, following to the content in "Mathematics I".

(5) As for the content (4)-b, programing should be restricted to the level of Euclidean algorithm and calculation of root by iteration.

VI. Mathematics C

1. Objectives

Through using computers from the viewpoint of applied mathematical science, to help students understand matrix and linear computation, various curves, numerical computation or statistics, and to encourage them to master knowledge and skills, and to develop their abilities to think and cope with mathematically in dealing with various phenomena.

2. Content

(1) Matrix and Linear Computation

a. Matrix

(i) matrices and their operations
sum, difference, multiplication by scalar

(ii) product of matrices and inverse matrix

b. Simultaneous linear equations

(i) representation by matrix

(ii) method of solution by elimination

【Terms/Symbols】 A '

(2) Various Curves

a. Algebraic expressions and geometrical figures

(i) curve represented by equation

(ii) ellipse and hyperbola

b. Parametric representation and polar coordinate

(i) parametric representation and polar coordinate

(ii) polar coordinate and polar equation

(iii) various curves

【Terms/Symbols】 focus, directrix

(3) Numerical Computation

a. Approximate solution of equation

b. Numerical integration

(i) mensuration by parts

(ii) approximate computation of area

(4) Statistics

a. Arrangement of statistical data

(i) representative values and measures of dispersion

(ii) correlation

b. Statistical inference

(i) population and sample

(ii) normal distribution

(iii) ideas of statistical inference

【Terms/Symbols】variance, standard deviation, coefficient of correlation, estimation

3. Remarks concerning Content

(1) In accord with the actual state of students taking this subjects, the teaching should consist of sections appropriately chosen from content (1) to (4)

(2) As for the content (1)-a, 3×3 matrices should be taught. However, regarding computing to inverse matrices, the extent should be limited to 2×2 matrices.

(3) As for the content (2), the teacher should help students observe and consider various curves by making use of computers and others, and become able to actually draw simple geometrical figures.

(4) As for the content (3)-a, the extent should be limited to the Newton's method or method of bisection. Furthermore, in relation to this, though it may be possible to

allude to approximate expressions, error and significant figures etc., only simple cases should be dealt with through actual examples in such teaching.

(5) As for the content (4)-b, the teacher should not go too far to the theoretical consideration.

[III] THE CONSTRUCTION OF TEACHING PLANS AND REMARK CONCERNING CONTENT IN EACH SUBJECT

1. In designing teaching plans, the following points should be taken into consideration.

(1) When students take "Mathematics II" and "Mathematics III", they should follow the order of "Mathematics I", "Mathematics II" and "Mathematics III".

(2) "Mathematics A" should be taken in parallel with "Mathematics I" or following to "Mathematics I", and "Mathematics B" and "Mathematics C" should be taken following to "Mathematics I".

(3) In case where some of "mathematics" are taken in parallel, the teacher should devise a close mutual relation among content of each "mathematics" and pay attention to the systematic nature of the learning content.

2. In teaching the content shown in [II], the follwing points should be considered.

(1) Terms and symbols listed under the content of each subject are shown for the purposes of clarifying the extent and range which are to be treated in the subject. In the teaching of subject, it is necessary to relate these terms and symbols with the content of the subject.

(2) The teacher should make active use of educational media such as computers, so as to improve the effectiveness of teaching.

(3) In the teaching of computation, the teacher should have students use hand-held calculators and computers as an occasion demands, so as to improve the effectiveness of learning.

SCIENCE MATHEMATICS COURSE

1. The Science Mathematics Course is one of the Specialized Courses in the Upper Secondary School System which provides a curriculum based on the objectives mentioned below, and contains the following two subjects concerning mathematics:

   Mathematics I, Mathematics II,

   and

   Physics, Chemistry, Biology, Earth Science.

2. Credits given for completion of these courses are to be decided by each school authority.

SCIENCE MATHEMATICS

[I] OBJECTIVES OF THE COURSE

To help students deepen their systematic understanding of the fundamental concepts, principles and laws of natural science and mathematics through processes of investigating natural phenomena, and to foster their abilities and attitudes to think and cope with scientifically and mathematically.

[II] SUBJECTS OF THE COURSE

I. Mathematics I in the Course

1. Objectives of the Subject

Through students' formation of fundamental concepts of mathematics and their systematic understanding of principles and rules of mathematics, to help students appreciate mathematical way of viewing and thinking and to encourage them to master basic knowledge and skills, and to develop their abilities to utilize them exactly.

2. Content of the Subject

(1) Mathematics and Computer

(2) Treatment of Numbers of Cases and Probability

(3) Plane Geometry

(4) Geometrical Figures and Mensuration

(5) Algebraic Expressions and Functions

(6) Sequences

3. Remarks concerning Content of the Subject

(1) As for the content (1) to (6), the teacher should refer to "Content" and "Remarks concerning Content" in "Mathematics I" and "Mathematics A" and give instruction by developing or expanding the content of those subjects, as an occasion demands.

(2) As for the content (1), the teacher should give instruction to it by adding the content (4) in "Mathematics B".

(3) As for the content (5), the teacher should give instruction to computation of fractional expressions and simple fractional functions, and as regards this, the teacher should give instruction to solving simple equations and inequalities within the real number system.

(4) As for the content (6), the teacher should give instruction to the content (1)-b (i) and -(ii) in "Mathematics III".

II. Mathematics II in the Course

1. Objectives of the Subject

To help students form concepts in each area of algebra•geometry, analysis and probability•statistics, deepen their understanding of principles and improve their abilities to express mathematically and to think logically, and to foster their inquisitive attitude and creative ability in considering phenomena.

2. Content of the Subject

A. Algebra • Geometry

(1) Curves and their Representation

(2) Vectors

(3) Complex Numbers and Complex Number Plane

(4) Matrix and Linear Computation

B. Analysis

(1) Various Functions

(2) Differential Calculus and its Applications

(3) Integral Calculus and its Applications

(4) Numerical Computation

C. Probability・Statistics

(1) Probability Distribution

(2) Statistical Processing

D. Project Study

3. Remarks conerning Content of the Subject

(1) As for the content A, B and C, the teacher should refer to "Content" and "Remarks concerning Content" in "Mathematics II", "Mathematics III", "Mathematics B" and "Mathematics C" and give instruction by developing or expanding the content of those subjects, as an occasion demands.

(2) As for the content B-(1), the teacher should give instruction to idea of inverse function, simple irrational functions and inverse trigonometric functions.

(3) As for the content B-(3), the teacher should give instruction to the meaning and solution method of such simple differential equations as $\frac{dy}{dx} = ky$ (k is a constant).

(4) As for the content D, the teacher should suitably set up project themes that were developed or expanded from the content A, B and C, and give consideration to use such appropriate methods in teaching as lectures, reading studies and exercises.

【Physics, Chemistry, Biology and Earth Science are omitted.】

【III】 THE CONSTRUCTION OF TEACHING PLANS AND REMARKS CONCERNING CONTENT IN EACH SUBJECT

1. In designing teaching plans, the following points should be taken into consideration.

(1) "Mathematics II in the Course" should be taken following to "Mathematics I in the Course".

(2) In teaching "Mathematics I in the Course" and "Mathematics II in the Course", the teacher should make active use of computers so as to deepen students' visual understanding of mathematical · scientific phenomena and their recognition of rules through many computational trials.

【Points following these two are omitted, since those points have no relation with mathematics.】

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